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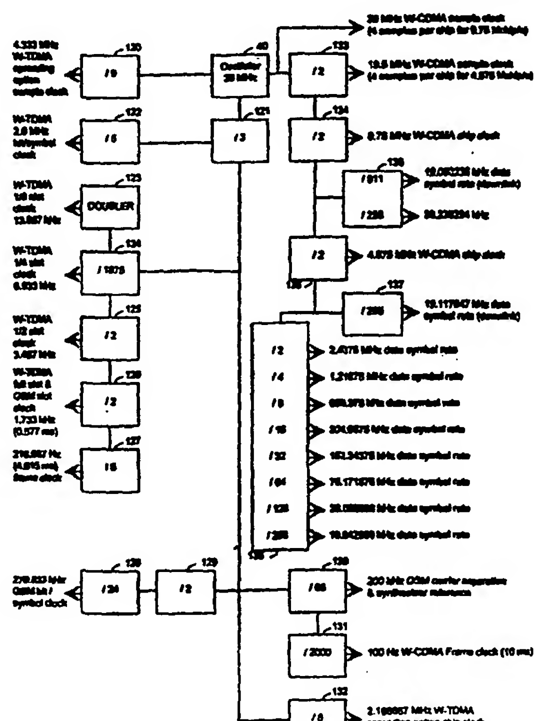
(54) Title: GENERATING FREQUENCIES FOR A MULTIMODE DEVICE OF A RADIO SYSTEM

(57) Abstract

In a multimode radio device, whose operating modes are a combination of the following: GSM/DCS, wideband-TDMA, wideband-CDMA, all required constant frequency signals are generated from a frequency generated by a common reference frequency oscillator (40). The frequencies are generated by integer division, and possibly by some additionally required frequencies multipliers.



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Generating frequencies for a multimode device of a radio system

The invention relates generally to generating internal frequency signals in a radio device. The invention relates particularly to generating frequencies in a multimode device which can operate according to the specifications of several different systems.

Digital radio devices require several constant frequency signals at different frequencies. Transmission and reception is usually done by frames, which can be further divided into time slots. Certain clock signals are required to generate and interpret the slots and frames with a correct timing. Timing signals are also required to realize the modulation and demodulation according to bits and/or bit combinations at an agreed bit rate; these timing signals depend on the transmission bit rate and also on the multiple access and modulation methods. Many systems enable the use of several data transmission modes, thus necessitating different bit rates.

Figure 1 shows schematically a radio device having a transmitter section 10 and a receiver section 11 which are controlled by a common timing and control block 12 and which use the same frequency synthesizer for generating the radio frequencies. In the transmitter section there is connected in series a speech coder 10a, a channel coder 10b, a frame interleaving block 10c, a multiple access implementing block 10d, a modulator 10e and the transmitter radio frequency section 10f, of which the latter is connected through an antenna switch to the antenna 15. For reception the antenna switch 14 can connect the antenna 15 to the receiver's radio frequency section 11a, which is followed by a series connection of an A/D converter 11b, a detector block 11c, a deinterleaving block 11d, a channel decoder 11e and a speech decoder 11f. The timing and control block 12 supplies to the multiple access implementing block 10d constant frequency signals which synchronize the frames, time slots and symbols (bits or bit combinations), and to the modulator 10e a sampling frequency signal with the aid of which the modulator generates the I and Q modulation signals required by the RF sections. The timing and control block 12 further supplies to the transmitter's radio frequency block 10f the constant frequency signals which align the frames, time slots and the sampling. The frequency synthesizer 13 supplies the PLL (Phase Locked Loop; not separately shown in the figure) reference frequency to the block 12 and generates also the required mixing frequencies for the radio frequency sections 10f and 11a of the

transmitter and the receiver. The timing and control block 12 further supplies the A/D converter 11b with a signal which controls the sampling frequency, and the detector block 11c with the synchronizing signals for frames, time slots and symbols.

Current digital mobile phone systems, such as the European-originating GSM (Global System for Mobile telecommunications) and the systems DCS or DCS1800 (Digital Communications System at 1800 MHz) and PCN (Personal Communications Network) developed from the GSM, the US systems D-AMPS (Digital Advanced Mobile Phone Service) and PCS (Personal Communications Services) and the Japanese PDC (Personal Digital Cellular), are so called second generation systems, and they have usually a national coverage (however, regarding GSM almost whole Europe). The aim of several international quarters is a third generation system which could be used everywhere on the globe. The European Telecommunications Standards Institute (ETSI) has a proposal for a third generation system called UMTS (Universal Mobile Telecommunications System). Within ITU-R (International Telecommunication Union, Radio communication sector) the third generation system is called FPLMTS (Future Public Land Mobile Telecommunication System) or IMT2000 (International Mobile Telecommunications at 2000 MHz). There is no general consensus regarding the realization of the air interface, so a third generation digital terminal probably must be able to communicate via several air interfaces. Further the terminal should also act as a terminal of at least one second generation system in order to have a smooth transition to the new system. 'Air interface' means all such definitions which have to be made concerning e.g. modulation method, multiple access method, frequency and timing decisions, and data communication rates, so that the communication between a terminal and a base station would be successful.

A terminal operating in several telecommunication systems is generally called a multimode terminal. In this application we discuss as an exemplary multimode terminal primarily a device which operates as a second generation GSM/DCS terminal and as a third generation UMTS terminal, whereby the UMTS mode particularly means utilization of such wideband communication features which are not available in GSM/DCS. Within the UMTS we separately discuss versions based on Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). Further we discuss the combination of these two systems so that a certain transmission frame is divided by the TDMA principle into time slots, which are further divided between a plurality of users by the CDMA principle. In

the design of base stations one is faced with largely similar problems if the same equipment has to operate as a base station for several systems. Thus the main part of the discussion below can be generalized to be applicable for multimode base stations.

The multimode terminals represent a set of new telecommunications concepts for which it is difficult to find examples in prior art. The most simple and obvious way to design a multimode terminal is to take individual terminals of different systems and to integrate them in a single mechanical entity. Clearly a device resulting from this is clumsy regarding its external features, and disadvantageous regarding manufacturing, because it includes a lot of redundancy on the equipment level. In a more advantageous solution the different systems can partly use the same components. Then a problem arises concerning how to adapt the operation of the same basic parts to the particular requirements of the different systems. One example of the special requirements is the need for constant frequency signals mentioned above.

The published international patent application number WO 96/08883 discusses a method for deriving some essential frequencies of a multimode terminal from a single reference oscillator. The terminal is a dual mode radio telephone that may act as a GSM telephone at approximately 900 MHz or a satellite telephone at approximately 1600 MHz. The channel grid frequencies may be derived from a single reference, because the channel grid of the first system (200 kHz) happens to be an integral multiple of the channel grid of the second system (3.125 kHz or 5 kHz). Also the mixing frequencies for intermediate frequency (IF) generation may be derived from a single reference frequency source, because the intermediate frequencies have suitably compatible values. The operation of a multimode radio terminal additionally requires, however, a lot of other constant frequency signals for example in the baseband part of the terminal, and the publication WO 96/08883 does not give any indications about how they should be produced.

The object of the invention is to present a method and a device for generating constant frequency signals in a multimode terminal. The object of the invention is that the method and the device according to the invention are advantageous regarding manufacturing, which requires a relatively low number of components.

The objects of the invention are attained by deriving the constant frequency signals required by the operation according to different systems from the same reference frequency oscillator signal.

The method according to the invention is characterized in that the operating modes of the multimode radio device are a combination of a first mode, which correponds to the operation of a second generation digital cellular radio system, and a second mode, whereby the constant frequency signals required by the first mode are derived from a common reference frequency and the constant frequency signals required by the second mode are results of integral multiplication and/or integral division of the constant frequency signals required by the first mode.

The invention also relates to a reference clock circuit arrangement for generating constant frequency signals in a multimode radio device, whose operating modes are a combination of a first mode, which correponds to the operation of a second generation digital cellular radio system, and a second mode. The reference clock circuit arrangement according to the invention is characterized in that it comprises one reference frequency oscillator and integer dividers and/or multipliers for deriving all constant frequency signals required by all operating modes from the common reference frequency generated by the reference frequency oscillator.

The invention further relates to a terminal and a base station of a cellular radio system. The terminal and the base station according to the invention are characterized in that they comprise at least one reference clock circuit arrangement like that described above.

According to the invention a common constant frequency reference signal can be used for generating all required constant frequency signals, irrespective of which combination of GSM/DCS functions and wideband communication features of the TDMA type or CDMA type is realized in the multimode terminal. The use of a common reference oscillator essentially simplifies the design and construction of a multimode terminal and a base station, and reduces the power consumption and manufacturing costs, because an accurate reference oscillator is a factor consuming electrical power and is also a relatively expensive component; the prior art use of several parallel oscillators would multiply the costs and power demand for generating the reference frequencies. Further, if the radio device has separate reference oscillators for the different systems and for RF, IF and baseband parts, it is inconvenient to change the operating from one system to another, and interference is easily generated at the sum or difference frequencies of the oscillators. Preferably the oscillating frequency of the common reference oscillator is 26 MHz, but some embodiments of the invention could also use a reference oscillator at 13 MHz, 39 MHz, 52 MHz or 104 MHz. Almost all required

frequencies are obtained from the reference oscillator frequency by a simple integer division, which is an operation easily realized on the component level.

The use of a common reference oscillator according to the invention requires, in order to obtain the greatest advantage, that the time and frequency parameters of the different systems, such as bandwidths, bit rates, frame lengths, time slots, sampling rates and other corresponding factors are selected so that the first system's frequency and/or its integer multiples and integer quotients can be directly used in another system. Because the GSM/DCS system is examined here as an example of second generation systems, in which the traffic channels are located with 200 kHz spacing on the frequency axis, the TDMA version of the UMTS system is proposed to have a bandwidth of 1.6 MHz, which is an integer multiple of 200 kHz. The CDMA based UMTS does not have a bandwidth of 1.6 MHz but an integer multiple of 200 kHz which is higher than the chip frequency. In the CDMA concept the channel interval is not yet fixed in the same way as in the TDMA and TDMA/CDMA concepts designed to be GSM compatible, but one preferable alternative is a multiple of 1.6 MHz (e.g. 4.8 MHz) which can facilitate frequency allocation in a situation where several air interfaces operate simultaneously. The carrier frequency reference 200 kHz required by the GSM system is obtained directly by integer division from the reference oscillator frequency, and from it the TDMA-UMTS carrier frequency reference 1.6 MHz is easily generated with means well known by a person skilled in the art. Further it is advisable to select the frame length in the UMTS system so that it is the same as in the second generation system (4.615 ms in GSM/DCS) or any fraction or integer multiple of this frame length.

Below the invention is described in more detail below with reference to the preferred embodiments presented as examples and to the enclosed Figures, in which:

Figure 1 shows schematically a known way to use constant frequency signals in a radio device;

Figure 2 shows a proposed frame structure for the UMTS system;

Figures 3a to 3e show different ways to divide the time slots of the frame structure;

Figure 4 shows a preferred principle according to the invention for deriving the frequencies;

Figure 5 shows in more detail one way to derive the frequencies;

Figure 6 shows in more detail another way to derive the frequencies;

Figure 7 shows in more detail a third way to derive the frequencies;

Figure 8 shows in more detail a fourth way to derive the frequencies;

Figure 9 shows in more detail a fifth way to derive the frequencies;

Figure 10 shows in more detail a sixth way to derive the frequencies;

Figure 11 shows in more detail a seventh way to derive the frequencies;

Figure 12 shows in more detail an eighth way to derive the frequencies;

Figure 13 shows in more detail a ninth way to derive the frequencies; and

Figure 14 shows a way to use a different reference frequency.

In connection with the description of prior art above reference was made to figure 1, so that below reference is made mainly to figures 2 to 14 when describing the invention and its preferred embodiments. Corresponding reference numerals are used for corresponding parts in the figures.

Figure 2 shows a proposed frame structure for the UMTS system using time division multiple access. As a distinction to the GSM system the multiple access according to figure 2 is below called W-TDMA (Wideband Time Division Multiple Access). This figure and the accompanying figures 3a to 3e are significant to the invention in that they show for which different purposes the constant frequency signals derived according to the invention from a single reference oscillator frequency are required. In the embodiment of figure 2 the length of the frame 20 is selected as 4.615 ms, which is the same as in the GSM system. The frame spans the bandwidth 1.6 MHz, and it is further divided into eight time slots 21 in the same way as in the GSM system. Another possible alternative is to divide the frames into 16 time slots. In this application it is assumed that in the TDMA mode of the UMTS each time slot can be further divided, when required, into smaller subslots both in the frequency and in the time directions, whereby each subslot of a time slot can be separately allocated to be used by a certain connection. Thus the system provides a possibility to create connections with different communication capacities between the base station and a terminal: the

maximum capacity is obtained for a connection which is allocated all time slots 21 of the whole frame 20, and in order of capacity the following connections are those which are allocated one or more complete time slots 21, and the smallest capacity units are subslots of the time slots 21, divided in different ways. A transmitting device, which uses a certain time slot or a subslot, transmits information as a burst in this time slot or in this subslot. The so called training sequence must be observed when the available capacity is calculated, the training sequence belonging to each burst and having a certain minimum length, whereby its effect, which decreases the useful capacity, appears particularly in the smallest subslots.

Preferably the frame length could also be a fraction or an integer multiple of 4.615 milliseconds. For instance, a frame with the length 2.308 ms would be half of the GSM/DCS frame length, and it could be divided into three, four, five or six basic time slots, which can be further divided into subslots in the same way as shown in figure 2 and in the figures 3a to 3e below. Digital data communication generally involves time interleaving the frames so that the transmitting device spreads the bits belonging to a certain logical frame into a number of consecutive transmission frames, so that a sudden communication error will not destroy a complete logical frame. If the frame length is short (for instance the above mentioned 2.308 ms), then the time interleaving can use more transmission frames than in the case of long frames. This is useful if the transmission frequency is changed between the transmission frames (so called frequency hopping); the more frames are used in the time interleaving, the more effectively the time interleaving and frequency hopping can spread the contents of a certain logical frame, and the less a certain sudden error can affect a single logical frame. In some cases it may also be useful to use a longer frame, whose length could be e.g. 9.231 ms (twice the GSM/DCS frame length) or another integer multiple of a known frame length of a second generation system. A long frame can facilitate the location of some control structures (the so called logical control channels) in the frame structure, because these channels require a quite low data communication capacity. Reserving a constant time slot or a constant subslot in each frame for the logical control channels can use a too large part of the whole system capacity, if the frame length is short.

The data communication capacity represented by a frame and its time slots depends i.a. on the modulation method, which can be e.g. Bin-O-QAM (Binary Offset Quadrature Amplitude Modulation) or Quat-O-QAM (Quaternary Offset Amplitude Modulation). The bandwidth efficiency of these methods is assumed as 1.625 bit/s/Hz and 3.25 bit/s/Hz, respectively. Assuming that the last mentioned of

these is used, whereby the total capacity of a signal with the bandwidth 1.6 MHz is about 5.2 Mbit/s. Assuming that 10% of the total capacity must be used for the frame structure synchronization and other general control requirements, then the useful communication capacity is about 4.659 Mbit/s for one UMTS carrier with the width of 1.6 MHz. Further it can be assumed that the transmitted information is convolution coded (for instance at a ratio 1/3) and punctured, whereby one could assume that a single UMTS carrier frequency can transmit information between a terminal and a base station at a maximum rate of about 2 Mbit/s. If the concerned carrier frequency is symmetrically time duplexed, then the useful data communication rate is maximum 1 Mbit/s in both directions. For the former modulation method (Bin-O-QAM) all capacity values are about one half of those mentioned above.

Figures 3a to 3e show five exemplary ways to handle the time slots. In figure 3a the whole time slot 21 is allocated to a single connection, so that according to the above presented reasoning the time slot represents a capacity of about 582 kbit/s (one eighth of 4.659 Mbit/s), when the effects of the convolution coding are disregarded. In figure 3b the time slot 21 is divided into two subslots 30. In figure 3c the time slot 21 is divided into four subslots, of which one subslot 31 for Quat-O-QAM modulation has a capacity of about 132 kbit/s and for Bin-O-QAM modulation about 66 kbit/s, when the effect of the training sequence is observed. In figure 3d the time slot 21 is divided into 8 subslots, whereby the capacity of one subslot 32 roughly corresponds to the capacity of the current GSM system speech slot (in GSM the bandwidth is 200 kHz and the length of the speech time slot is the same as the length of the time slot 21 in figure 3d). With Bin-O-QAM modulation the useful data communication capacity of the subslot 32 in figure 3d is estimated as 28.8 kbit/s, where the effects of the training sequence and the suitable punctured convolution coding with the ratio 1/3 are observed. In figure 3e the time slot 21 is divided in the frequency direction into eight subslots, whereby each subslot 33 corresponds, regarding both its bandwidth and duration, to the speech time slot of the current GSM system. In addition to the alternatives presented in figures 3a to 3e it is also possible to divide the time slots in other ways, e.g. in the frequency direction into two, three, five, six, ten or twelve subslots. Further the time slot could be divided according to the invention by the CDMA method, whereby during a certain time slot there are several simultaneous connections spread over the available frequency band with orthogonal or quasi-orthogonal spreading codes.

On the basis of the time slots and their subslots described above it can be said that a multimode terminal (or base station) requires at least the following frequencies:

216.667 Hz	frame clock, corresponds to the frame length (4.615 ms)
1.733 kHz	slot clock, corresponds to the time slot length (0.577 ms)
3.467 kHz	slot clock, corresponds to 1/2 time slot length (0.288 ms)
6.933 kHz	slot clock, corresponds to 1/4 time slot length (0.144 ms)
13.867 kHz	slot clock, corresponds to 1/8 time slot length (0.072 ms)
200 kHz	carrier frequency separation according to the GSM system
270.833 kHz	bit / symbol clock according to the GSM system
325 kHz	bit / symbol clock according to the Enhanced GSM system (refers to the application of Bin-O-QAM modulation in a system according to the GSM specifications)
346.666 kHz	bit / symbol clock according to another variation of the Enhanced GSM system
361.111 kHz	bit / symbol clock according to another variation of the Enhanced GSM system
2.6 MHz	bit/symbol clock corresponding to the 2.6 Mbit/s capacity of the frame using Bin-O-QAM modulation
5.2 MHz	bit/symbol clock corresponding to the 5.2 Mbit/s capacity of the frame using Quat-O-QAM modulation.

Above reference was made to the fact that a W-TDMA time slot can be further divided also according to the CDMA principle. It was assumed that the length of one CDMA time unit (the so called chip time) is about 0.462 μs, which corresponds to a chip frequency of 2.166667 MHz. The sampling in the reception requires at least the double frequency, whereby the list of the required frequencies can be continued with the rows below:

2.166667 Mhz	chip frequency in W-TDMA-CDMA multiple access
4.333 MHz	sampling frequency in W-TDMA-CDMA reception.

If a W-TDMA time slot with the length 0,577 ms is divided in another way than into two, four and/or eight subslots, then instead of the above presented 1/2, 1/4 and 1/8 slot clocks at least some of the frequencies listed below are required to clock the subslots of the time slot:

5.2 kHz	slot clock, corresponds to the length of 1/3 time slot (0.192 ms)
10.4 kHz	slot clock, corresponds to the length of 1/6 time slot (0.096 ms)

20.8 kHz slot clock, corresponds to the length of 1/12 time slot (0.048 ms)
8.667 kHz slot clock, corresponds to the length of 1/5 time slot (0.115 ms)
17.333 kHz slot clock, corresponds to the length of 1/10 time slot (0.0577 ms).

If the frame length differs from the above mentioned 4.615 ms the frame clocking may require clock signals differing from the above listed:

108.333 Hz frame clock, corresponds to the double frame length (9.231 ms)
433.333 Hz frame clock, corresponds to the half frame length (2.308 ms).

Next we shall examine, instead of the W-TDMA multiple access the W-CDMA multiple access, in which the available bandwidth is divided with orthogonal or quasi-orthogonal spreading codes between different connections. Then the required frequencies depend on the system's chip frequency and spreading ratio. In a time division system the different capacities allocated to different connections are represented by time slots and frequency intervals of different sizes; in a system of the W-CDMA type a high spreading ratio corresponds to a low user data rate on the connection, and vice versa. In practice probably the minimum spreading ratio is 4 and the maximum spreading ratio 255 or 256. The symbol rate required by a certain spreading ratio is obtained by dividing the system's chip frequency by the spreading ratio. Reception of a code division transmission requires a sampling frequency, which preferably is four or five times the chip frequency.

Figure 4 shows a principle according to which the frequencies required by the different modes of a multimode terminal (or base station) are derived from the reference frequency oscillator 40 in different branches. Block 41 illustrates the deriving of those frequencies which are required for the device to be compatible with a second generation digital mobile phone system, such as the GSM. Block 42 illustrates the deriving of those frequencies which are required by the W-TDMA mode, and block 43 illustrates the deriving of the frequencies for the W-CDMA mode. In a versatile UMTS multimode terminal (or base station) all blocks 41, 42 and 43 are realized, whereby the device can operate in the UMTS system, disregarding which multiple access scheme (TDMA or CDMA) is used by the system. A simpler system could comprise for instance only the blocks 41 and 42 or the blocks 41 and 43, whereby the narrow band communication services are compatible with the second generation system, and broad band services requiring a high capacity operate in either multiple access scheme. Of course it is also possible to present a device having only the blocks 42 and 43, or only one of these. A device having only the block 41 corresponds to the current second generation

devices. In some cases the generation of frequencies illustrated by the blocks 41, 42 and 43 are not clearly distinct, but first for instance one of the GSM/DCS frequencies is derived from the oscillator frequency, and then a W-TDMA frequency is further derived from this frequency. Detailed embodiments of the invention in order to derive certain frequencies are discussed more closely below with reference to figures 5 to 13.

The basic frequency generated by the oscillator 40 is at least 13 MHz, because this frequency is a common basic frequency in GSM devices and because the main part of the required frequencies can be generated from it by integer division, according to the examples presented below. During the research which led to this invention it was found that the most favorable basic frequency of the oscillator 40 was 26 MHz, particularly in a device having a narrow-band communication link compatible towards the second generation (GSM/DCS compatible) and a wideband link of the W-TDMA type. It can also be 39 MHz, 52 MHz or 104 MHz, but higher frequency means a higher power consumption in the oscillator and it increases the interference susceptibility of the oscillator. Of these oscillators one operating at 104 MHz would further be susceptible to interference from the FM frequencies used for broadcasting. Further a signal from oscillators operating at 52 MHz and higher frequencies will produce intermodulation products which interfere with radio signals at 900 MHz and 1800 MHz.

Figure 5 shows how constant frequency signals are derived from the 26 MHz reference frequency in a device according to a preferred embodiment of the invention, which has a narrow-band communication link compatible towards the second generation (GSM/DCS compatible) and a wideband link of the W-TDMA type and in which the frame's time slot with the length 0.577 ms is divided into at most eight subslots. The frequency of the oscillator 40 is 26 MHz. Each block 50 to 58 represents a division of the frequency by an integer shown within the block. This results in the frequencies 200 kHz, 2.6 MHz, 361.111 kHz, 346.666 kHz, 325 kHz, 270.833 kHz, 13.867 kHz, 6.933 kHz, 3.467 kHz, 1.733 kHz and 216.677 Hz, the use of which was described above.

Figure 6 shows how the constant frequency signals are derived from the reference frequency 13 MHz, when the device in other respects is similar to that in the case of figure 5. The blocks 60 to 63 generate the same frequencies 200 kHz, 2.6 MHz, 361.111 kHz, 346.666 kHz, 325 kHz, 270.833 kHz as the blocks 50 to 53 in figure 5, with the exception that a doubler 62b and a divider 62c are used instead of the single divider 52b of figure 5. In a similar way the blocks 65 to 68 generate the

frequencies 933 kHz, 3.467 kHz, 1.733 kHz and 216.677 Hz in the same way as the blocks 55 to 58 in figure 5. The blocks 62b and 64 do not represent integer divisions but frequency multipliers, which as a device is known per se. Block 62b doubles the 13 MHz reference frequency to 26 MHz and block 64 generates the frequency 13.867 kHz required to clock the 1/8 time slots by multiplying the frequency 6.933 kHz by two. The required clocking of the 1/8 time slots can also be solved by using the frequency 6.933 kHz (for the 1/4 time slot) as a reference and counting symbols (in transmission) or samples (in reception).

Figures 7 and 8 show how constant frequency signals are derived from the reference frequency 13 MHz when the device in other respects is similar to that in the case of figure 6, but the W-TDMA time slots are divided into 12 subslots (figure 7) or 10 subslots (figure 8). The blocks 70 to 73 and 80 to 83 correspond to the blocks 60 to 63 of figure 6. The blocks 74 to 78 and 84 to 87 are all integer divisions, which result in the required frequencies.

Figure 9 shows how constant frequency signals are derived from the reference frequency 13 MHz in a device according to a preferred embodiment of the invention, which has a narrow-band communication link compatible with the second generation (GSM/DCS compatible) and a wideband link of the W-CDMA type, in which the chip frequency is 4.3333 MHz. Compatibility with GSM/DCS requires a 200 kHz carrier reference, a bit frequency signal 270.833 kHz, a time slot signal 1.733 kHz and a frame clock signal 216.667 Hz. These are generated in the blocks 90, 91, 92, 93 and 94. The block 95 divides the 200 kHz carrier frequency reference signal by 2000 in order to generate the CDMA frame alignment signal of 100 Hz (the CDMA frame length is here assumed to be 10 ms). The block 96 generates the chip frequency 4.3333 MHz and the block 97 contains alternative integer divisors corresponding to the spreading ratios 4, 8, 16, 32, 64, 128 and 256 which generate the symbol rates 1083.333 kHz, 541.667 kHz, 270.833 kHz, 135.417 kHz, 67.708 kHz, 33.854 kHz and 16.927 kHz. In some cases the spreading ratio 256 can be replaced by the spreading ratio 255 in down-link communication, whereby the corresponding symbol rate is 16.993 kHz.

Figure 10 corresponds to figure 9 in other respects, but the frequency of the oscillator 40 is 26 MHz and the chip frequency is 5.2 MHz. Due to the higher chip frequency the symbol rates corresponding to the different spreading ratios are also higher than in figure 9. The block 100 divides the oscillator frequency by two, and then the blocks 101 to 106 generate the same frequencies as the blocks 90 to 95 in figure by using the same divisions. The block 107 generates the chip frequency 5.2

MHz and the block 108 contains alternative integer divisors corresponding to the spreading ratios 4, 8, 16, 32, 64, 128 and 256 which produce the symbol rates 1300 kHz, 650 kHz, 325 kHz, 162.5 kHz, 81.25 kHz, 40.625 kHz and 20.3125 kHz. Also in this case the spreading ratio 256 can be replaced by the spreading ratio 255 in downlink communication, whereby the corresponding symbol rate is 20.392 kHz.

Figure 11 shows a combination of the embodiments in figures 9 and 10. The frequency of the oscillator 40 is 26 MHz and the blocks 110 to 116 generate from it frequencies by the same operations as the blocks 100 to 106 in figure 10. The block 117 divides the oscillator frequency by 6, whereby the chip frequency will be 4.3333 MHz, in the same way as in figure 9. The integer divisions contained in block 118 generate the same frequencies corresponding to the same spreading ratios as the block 97 in figure 9.

Figure 12 shows how the constant frequency signals are derived from the reference frequency 39 MHz in a triple mode multimode device having all functions represented by the blocks 41, 42 and 43 in figure 4. The block 40 is a 39 MHz oscillator. The block 120 generates by a direct integer division the 4.333 MHz sampling frequency for the W-TDMA-CDMA function. The other GSM/DCS and W-TDMA frequencies are derived from the frequency 13 MHz, which is generated by the block 121. The blocks 122 to 130 represent the blocks 60, 61 and 63 to 68 with a slight change in their order (122 = 61, 123 = 64, 124 = 65, 125 = 66, 126 = 67, 127 = 68, 128 = 63, 130 = 60), and it would be easy to add in parallel with the block 128 a group of blocks corresponding to the blocks 62a, 62b, 62c and/or 62d in order to generate the frequencies 346.666 kHz, 361.111 kHz and/or 325 kHz. The block 132 generates the chip frequency 2.166667 MHz for the W-TDMA-CDMA function.

The block 131 generates the frequency 100 Hz which corresponds to the frame length 10 ms used by the W-CDMA function. The W-CDMA section in figure 12 supports two alternative chip frequencies, which are 4.875 Mchip/s and 9.75 Mchip/s. The quadruple sampling frequency 39 MHz corresponding to the latter chip frequency is obtained directly from the oscillator 40. The quadruple sampling frequency (19.5 MHz) corresponding to the former chip frequency is obtained from block 133. The real chip frequencies are obtained from the blocks 134 and 136, and the block 135 generates the symbol rates 19.080235 kHz and 38.235294 kHz corresponding to the spreading ratios 511 and 255. Correspondingly the block 137 generates the symbol rate 19.117647 kHz corresponding to the spreading rate

255 at the lower chip frequency. The highest spreading ratios (511 at the higher and 255 at the lower chip frequency) are here intended particularly to be used for the downlink, or for the transmission from the base station to the terminal. When required it is also possible to use the spreading ratio 256. The block 138 contains several alternative integer divisions corresponding to the spreading ratios 2, 4, 8, 16, 32, 64, 128 and 256. The corresponding symbol rates are in order 2.4375 MHz, 1.21875 MHz, 609.375 kHz, 304.6875 kHz, 152.34375 kHz, 76.171875 kHz, 38.085938 kHz and 19.042969 kHz.

Figure 13 shows how the constant frequency signals are derived from the reference frequency 26 MHz in a triple mode multimode device. Particularly regarding W-TDMA this is a more advantageous embodiment than that of figure 12 presented above, because also the clock frequency for the 1/8 time slot is obtained by integer division from the reference frequency. The block 140 corresponds to the block 120 of figure 12, however so that the divisor is 6 and not 9. The block 141 generates the frequency 2.6 MHz directly from the reference frequency by one division, and the block 142 generates the desired clock frequency for the 1/8 time slot, also by one division. The block 143 generates from the reference frequency a signal of 13 MHz, from which the blocks 144 to 147 generate the same frequencies as the blocks 124 to 127 in figure 12. The blocks 148 to 149 correspond to the blocks 130 and 131 of figure 12. The blocks 150 to 152 generate the same frequencies as the blocks 128, 129 and 132 in figure 12.

In figure 13 the highest frequency for the W-CDMA function is the oscillator's frequency 26 MHz, which is used in the embodiment of figure 13 as a fivefold sampling frequency corresponding to the 5.2 MHz chip frequency (block 153). The block 154 generates the symbol rates 1300 kHz, 650 kHz, 325 kHz, 162.5 kHz, 81.25 kHz, 40.625 kHz, 20.3125 kHz and 20.392157 kHz corresponding to the spreading ratios 4, 8, 16, 32, 64, 128, 256 and 255. The spreading ratio 255 is most preferably used for the downlink transmission, but it can also use the spreading ratio 256.

In figures 12 and 13 it was assumed that in the W-TDMA section the 0.577 time slot was divided into two, four and eight parts. However, in the embodiments shown in figures 7 and 8 it is shown how the required frequencies are derived from a 13 MHz signal when the time slot is divided in other ways. For a person skilled in the art it is clear that the "division trees" of figures 7 and 8 can be added to the embodiments of figures 12 and 13 at a point having the frequency 13 MHz (in figure 12 below block 121, and in figure 13 below block 143), so that these

alternatives are also available in the triple-mode devices shown in figures 12 and 13. Similarly, any of the means shown in figures 10 and 11 to generate the W-CDMA frequencies from the reference frequency 26 MHz can replace the blocks 153 and 154 in figure 13.

Above it was referred to the fact that a frame can also have another length than the 4.615 ms known from GSM/DCS. For instance, the frequency 433.333 Hz corresponding to a frame with the half length (2.308 ms) is in the embodiments of figures 5 to 13 most advantageously obtained from that block which generates the frequency 1.733 kHz corresponding to the time slot length 0.577 ms (blocks 57, 67, 77, 86, 103, 113, 126 and 146) by further dividing by four the frequency generated by that block. The frequency 108.333 Hz corresponding to the double frame length (9.231 ms) is correspondingly most advantageously obtained from the block which generates the frequency 216.667 Hs corresponding to the frame length 4.615 ms (blocks 58, 68, 78, 87, 93, 104, 114, 131 and 147) by further dividing by two the frequency generated by that block.

There is a possibility that at least one of of the chip rates of 4.096 Mchip/s, 8.192 Mchip/s and 16.384 Mchip/s will be adopted as the chip rate of a wideband-CDMA system. Therefore it would be advantageous to be able to produce a frequency of 16.384 MHz, from which the lower frequencies 8.192 MHz and 4.096 MHz are easy to derive through one and two divisions by two respectively. Figure 14 shows the generation of a 13 MHz frequency and a 16.384 MHz frequency from the output of a 19.2 MHz reference oscillator 155. The former requires division by 96 in block 156 and multiplication by 65 in block 157, and the latter requires division by 75 in block 158 and multiplication by 64 in block 159. For the quadruple oversampling frequency of a 4.096 Mchip/s received signal, one may use the 16.384 MHz frequency, and the oversampling frequencies of the other chip rates are easily generated from the 16.384 MHz frequency through doubling. The oversampling frequency does not have to be four times the chip rate; in many cases a lower oversampling frequency is sufficient.

In order to show the versatility of the invention the embodiments presented above cover a very large number of frequencies and ways to generate them. If the system specifications do not require a certain terminal or base station to use a certain frequency mentioned in the above description, the generation of this frequency could simply be omitted. Similarly the generation of all frequencies (e.g. the Enhanced GSM frequencies) is not shown in each embodiment, but their generation can be readily added by comparing the discussed embodiments with

each other. Figure 5 shows how the Enhanced GSM frequencies can be derived from a 26 MHz reference frequency and figure 6 shows how they can be derived from a 13 MHz reference frequency or a 13 MHz frequency that is a result of an integral division and/or multiplication of some other reference frequency.

For a person skilled in the art it is clear that the divisors and/or multipliers shown in the figures presenting the detailed embodiments can be combined, if required. If for instance a frequency X is obtained from a frequency Y by dividing it first by 2 and then by 3, the invention does not require these divisions to be separate operations: in order to generate the frequency X the frequency Y can be directly divided by 6. Similarly, the divisors can be divided into their factors. If for instance a frequency XX is obtained from a frequency YY by dividing it by 9, and a frequency ZZ is obtained from the same frequency YY by dividing it first by 3 and then by 6, then a common predivider with the divisor 3 can be used for both. Thus the frequency XX is obtained from YY by dividing it first by 3 and then by 3, and ZZ is obtained from YY dividing it first by 3 and then by 6.

The invention shows how one constant frequency reference oscillator can be used in a simple way to generate all required constant frequency signals in a multimode terminal (or base station). In this way one can avoid the need for several oscillators and the increase in manufacturing costs and power consumption caused by this. Further it eliminates the inconveniences relating to a change of the oscillator during use. The reference clock arrangement according to the invention could naturally also be used in a radio device which has only one operating mode, but which is intended to operate in a multimode compatible system.

Claims

1. A method for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the spreading, modulation and carrier frequency references in a multimode radio device, **characterized** in that the operating modes of the multimode radio device comprise a combination of a first mode, which correponds to the operation of a second generation digital cellular radio system, and a second mode, whereby the constant frequency signals required by the first mode are derived from a common reference frequency (40) and the constant frequency signals required by the second mode are results of integral multiplication and/or integral division of the constant frequency signals required by the first mode.

2. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS and wideband-TDMA, **characterized** in that said reference frequency (40) is 26 MHz and that the frequencies below are derived from it by the following integer divisions:
/1875/2/2/2/8 → 216.667 Hz (58)
/1875/2/2/2 → 1.733 kHz (57)
/1875/2/2 → 3.467 kHz (56)
/1875/2 → 6.933 kHz (55)
/1875 → 13.867 kHz (54)
/130 → 200 kHz (50)
/96 → 270.833 kHz (53)
/80 → 325 kHz (52c)
/75 → 346.666 kHz (52b)
/72 → 361.111 kHz (52a)
/10 → 2.6 MHz (51).

3. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS and wideband-TDMA, **characterized** in that said reference frequency (40) is 13 MHz and that the frequencies below are derived from it by the following integer operations:
/1875/2/2/8 → 216.667 Hz (68)
/1875/2/2 → 1.733 kHz (67)

/1875/2 → 3.467 kHz (66)
/1875 → 6.933 kHz (65)
/65 → 200 kHz (60)
/48 → 270.833 kHz (63)
/40 → 325 kHz (62d)
*2/75 → 346.666 kHz (62b,62c)
/36 → 361.111 kHz (62a)
/5 → 2.6 MHz (61).

4. A method according to claim 3, **characterized** in that further the frequency 13.867 kHz is derived from the reference frequency by the integer division /1875 (65) and by a doubling multiplier (64).

5. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS and wideband-TDMA, **characterized** in that said reference frequency (40) is 13 MHz and that the frequencies below are derived from it by the following integer operations:
/625/2/2/3/8 → 216.667 Hz (78)
/625/2/2/3 → 1.733 kHz (77)
/625/2/2 → 5.2 kHz (76)
/625/2 → 10.4 kHz (75)
/625 → 20.8 kHz (74)
/65 → 200 kHz (70)
/48 → 270.833 kHz (73)
/40 → 325 kHz (72d)
*2/75 → 346.666 kHz (72b, 72c)
/36 → 361.111 kHz (72a)
/5 → 2.6 MHz (71).

6. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS and wideband-TDMA, **characterized** in that said reference frequency is 13 MHz and that the frequencies below are derived from it by the following integer operations:
/750/2/5/8 → 216.667 Hz (87)
/750/2/5 → 1.733 kHz (86)

/750/2 → 8.667 kHz (85)
/750 → 17.333 kHz (84)
/65 → 200 kHz (80)
/48 → 270.833 kHz (83)
/40 → 325 kHz (82d)
*2/75 → 346.666 kHz (82b, 82c)
/36 → 361.111 kHz (82a)
/5 → 2.6 MHz (81).

7. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the spreading, modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS and wideband-CDMA, **characterized** in that said reference frequency (40) is 13 MHz and that the frequencies below are derived from it by the following integer divisions:
/2/3750/8 → 216.667 Hz (93)
/2/3750 → 1.733 kHz (92)
/2/24 → 270.833 kHz (91)
/65/2000 → 100 kHz (95)
/65 → 200 kHz (94)
/3 → 4.3333 MHz (96)
and that at least one of the frequencies below are derived by at least one of the following integer divisions (97):
/3/4 → 1083.333 kHz
/3/8 → 541.667 kHz
/3/16 → 270.833 kHz
/3/32 → 135.417 kHz
/3/64 → 67.708 kHz
/3/128 → 33.854 kHz
/3/255 → 16.993 kHz
/3/256 → 16.927 kHz.

8. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the spreading, modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS and wideband-CDMA, **characterized** in that said reference frequency (40) is 26 MHz and that the frequencies below are derived from it by the following integer divisions:

/2/2/3750/8 → 216.667 Hz (104)
/2/2/3750 →> 1.733 kHz (103)
/2/2/24 → 270.833 kHz (102).
/2/65/2000 → 100 kHz (106)
/2/65 → 200 kHz (105)
/5 → 5.2 MHz (107)
and that at least one of the frequencies below are derived by at least one of the following integer divisions (108):
/5/4 → 1300 kHz
/5/8 → 650 kHz
/5/16 → 325 kHz
/5/32 → 162.5 kHz
/5/64 → 81.25 kHz
/5/128 → 40.625 kHz
/5/255 → 20.392 kHz
/5/256 → 20.3125 kHz.

9. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the spreading, modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS and wideband-CDMA, **characterized** in that said reference frequency (40) is 26 MHz and that the frequencies below are derived from it by the following integer divisions:
/2/2/3750/8 → 216.667 Hz (114)
/2/2/3750 → 1.733 kHz (113)
/2/2/24 → 270.833 kHz (112)
/2/65/2000 → 100 kHz (116)
/2/65 → 200 kHz (115)
/6 → 4.3333 MHz (117)
and that at least one of the frequencies below are derived by at least one of the following integer divisions (118):
/6/4 → 1083.333 kHz
/568 → 541.667 kHz
/6/16 → 270.833 kHz
/6/32 → 135.417 kHz
/6/64 → 67.708 kHz
/6/128 → 33.854 kHz
/6/255 → 16.993 kHz

/6/256 → 16.927 kHz.

10. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the spreading, modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS, wideband-TDMA and wideband-CDMA, **characterized** in that said reference frequency (40) is 39 MHz and that the frequencies below are derived from it by the following integer divisions:
/3/1875/2/2/8 → 216.667 Hz (127)
/3/1875/2/2 → 1.733 kHz (126)
/3/1875/2 → 3.467 kHz (125)
/3/1875 → 6.933 kHz (124)
/3/65 → 200 kHz (130)
/3/48 → 270.833 kHz (128)
/3/5 → 2.6 MHz (122)
/3/65/2000 → 100 Hz (131)
/2/2/2 → 4.875 MHz (136)
/2/2 → 9.75 MHz (134)
/2 → 19.5 MHz (133)
and that at least one of the frequencies below are derived by at least one of the following integer divisions (135, 137, 138):
/2/2/255 → 38.235294 kHz
/2/2/511 → 19.0809235 kHz
/2/2/2/2 → 2.4375 MHz
/2/2/2/4 → 1.21875 MHz
/2/2/2/8 → 609.375 kHz
/2/2/2/16 → 304.6875 kHz
/2/2/2/32 → 152.34375 kHz
/2/2/2/64 → 76.171875 kHz
/2/2/2/128 → 38.085938 kHz
/2/2/2/256 → 19.042969 kHz.

11. A method according to claim 10, **characterized** in that further the frequency 13.867 kHz is derived from the reference frequency by the integer division /3/1875 (124) and by a doubling multiplier (123).

12. A method according to claim 10 or 11, **characterized** in that further the following frequencies are derived from the reference frequency by integer division:
/3/6 → 2.166667 MHz (132)

/9 → 4.333 MHz (120).

13. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the spreading, modulation and carrier frequency references in a multimode radio device, whose operating modes are GSM/DCS, wideband-TDMA and wideband-CDMA, **characterized** in that said reference frequency (40) is 26 MHz and that the frequencies below are derived from it by the following integer divisions:

/2/1875/2/2/8 → 216.667 Hz (147)
/2/1875/2/2 → 1.733 kHz (146)
/2/1875/2 → 3.467 kHz (145)
/2/1875 → 6.933 kHz (144)
/2/65 → 200 kHz (148)
/2/3/16 → 270.833 kHz (151)
/1875 → 13.867 kHz (142)
/10 → 2.6 MHz (141)
/2/65/2000 → 100 Hz (149)
/5 → 5.2 MHz (153)

and that at least one of the frequencies below are derived by at least one of the following integer divisions (154):

/5/4 → 1300 kHz
/5/8 → 650 kHz
/5/16 → 325 kHz
/5/32 → 162.5 kHz
/5/64 → 81.25 kHz
/5/128 → 40.625 kHz
/5/256 → 20.3125 kHz
/5/255 → 20.392157 kHz.

14. A method according to claim 13, **characterized** in that further the following frequencies are derived from the reference frequency by integer division:

/2/3/2 → 2.166667 MHz (132)
/6 → 4.333 MHz (140).

15. A method according to claim 1 for deriving the constant frequency signals required by the bit, symbol, burst and frame alignment, and the spreading, modulation and carrier frequency references in a multimode radio device, **characterized** in that said reference frequency (155) is 19.2 MHz and that the

following secondary reference frequencies are derived from it by the following operations:

/96*65 → 13 MHz (156, 157)

/75*64 → 16.384 MHz (158, 159).

16. A reference clock arrangement for generating constant frequency signals in a multimode radio device, whose operating modes comprise a combination of a first mode, which correponds to the operation of a second generation digital cellular radio system, and a second mode, **characterized** in that it comprises one reference frequency oscillator (40) and integer dividers and/or multipliers for deriving all constant frequency signals required by all operating modes from the common reference frequency generated by the reference frequency oscillator.

17. A base station device of a cellular radio system, **characterized** in that it comprises at least one clock arrangement according to claim 16.

18. A base station device of a cellular radio system according to claim 17, **characterized** in that it is a multimode radio device whose operating modes are a combination of the following: GSM/DCS, wideband-TDMA, wideband-CDMA.

19. A terminal device of a cellular radio system, **characterized** in that it comprises at least one clock arrangement according to claim 16.

20. A terminal device of a cellular radio system according to claim 19, **characterized** in that it is a multimode radio device whose operating modes are a combination of the following: GSM/DCS, wideband-TDMA, wideband-CDMA.

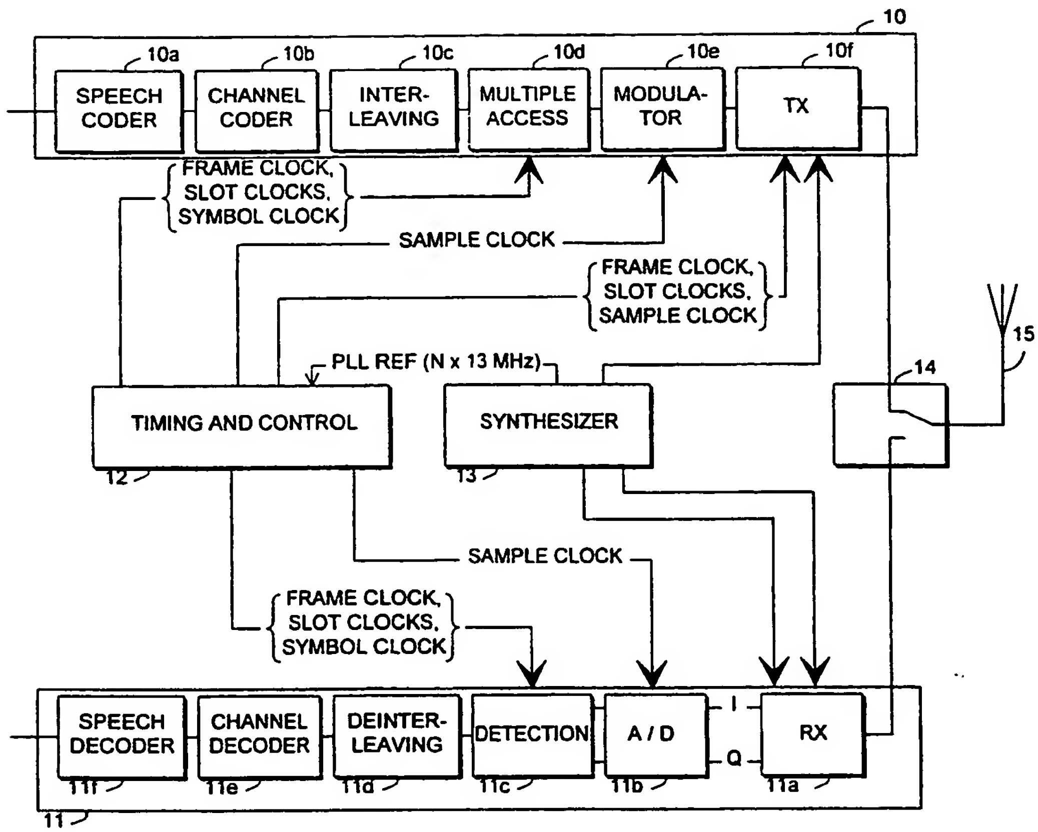


Fig. 1
PRIOR ART

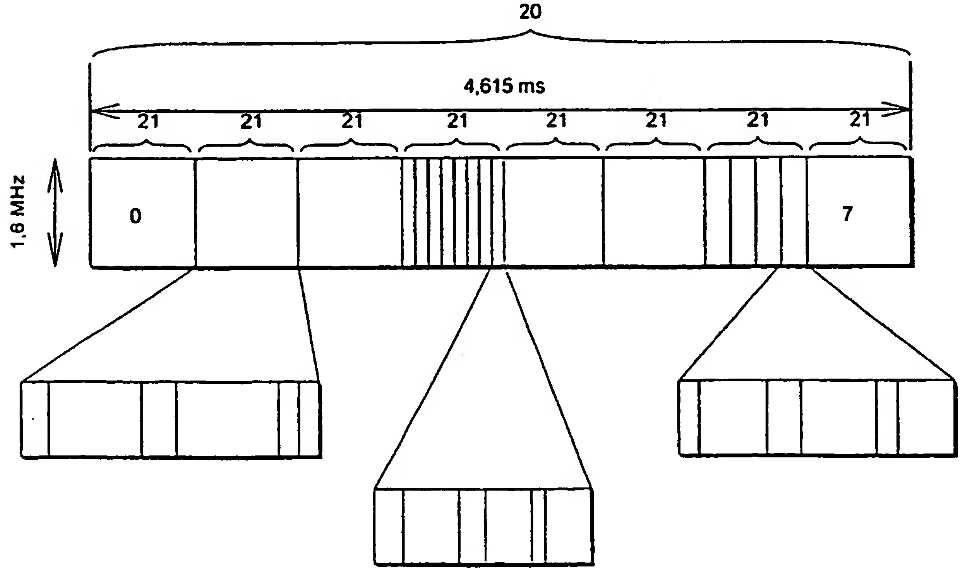


Fig. 2

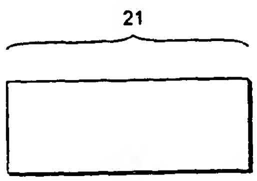


Fig. 3a

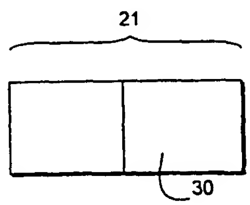


Fig. 3b

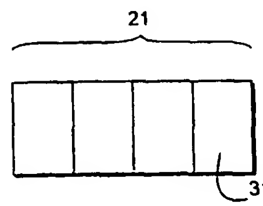


Fig. 3c

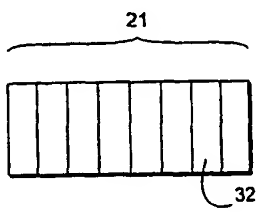


Fig. 3d

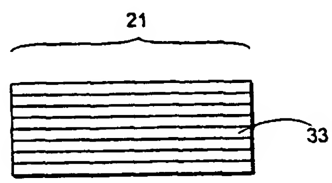


Fig. 3e

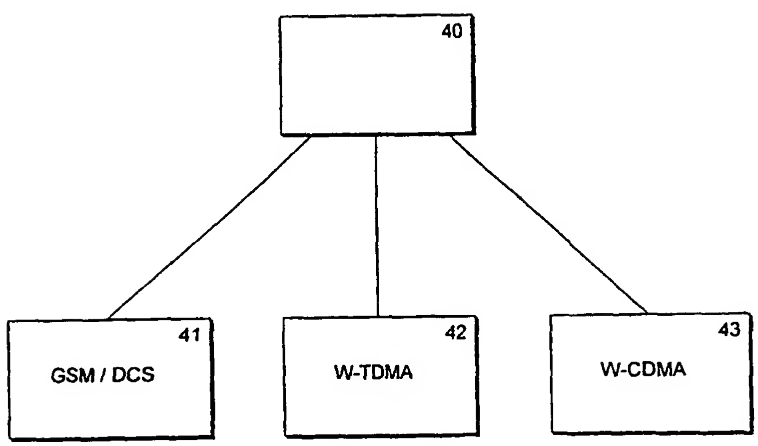


Fig. 4

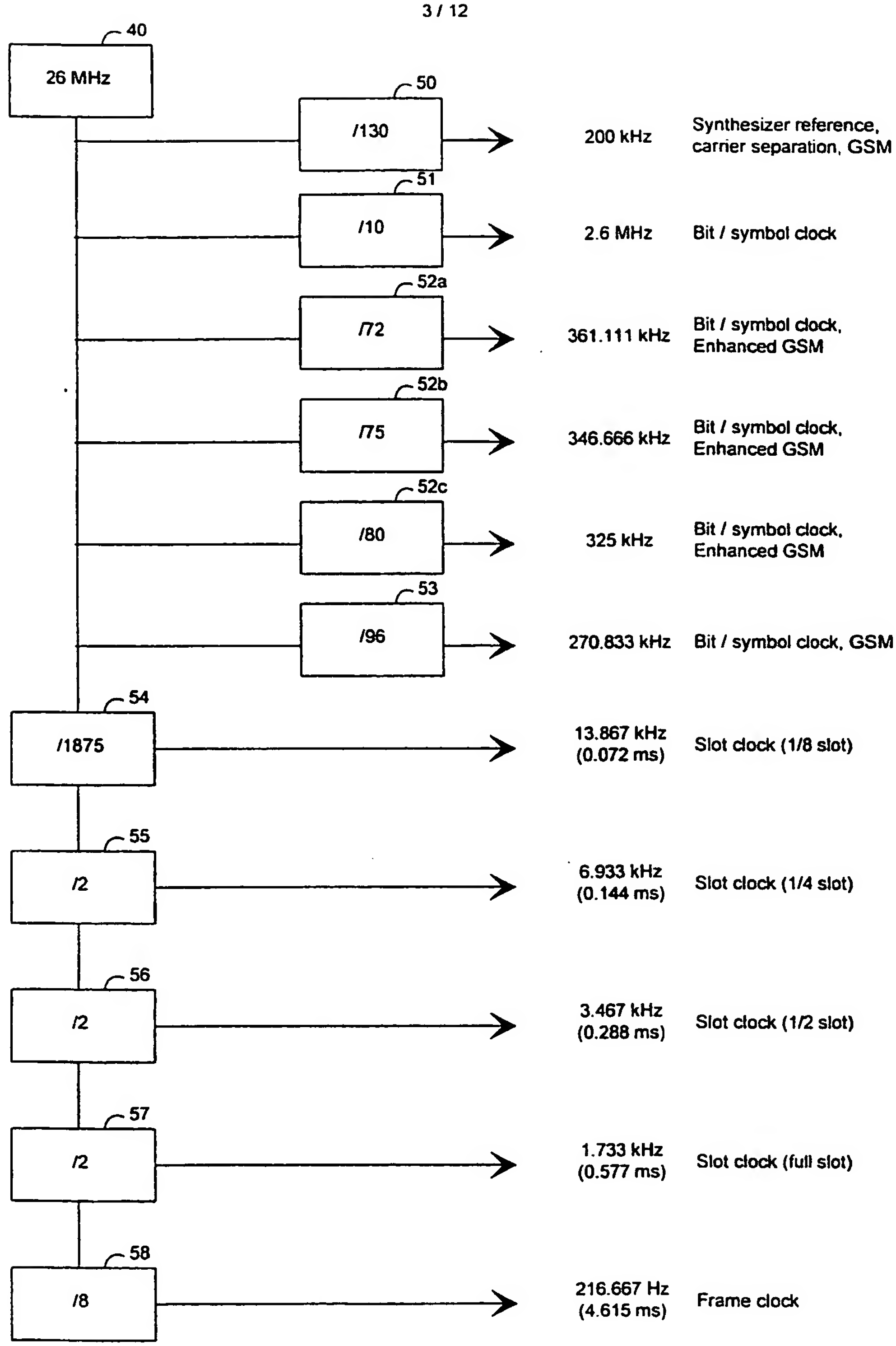

40
26 MHz
50
/130
200 kHz
Synthesizer reference, carrier separation, GSM
51
/10
2.6 MHz
Bit / symbol clock
52a
/72
361.111 kHz
Bit / symbol clock, Enhanced GSM
52b
/75
346.666 kHz
Bit / symbol clock, Enhanced GSM
52c
/80
325 kHz
Bit / symbol clock, Enhanced GSM
53
/96
270.833 kHz
Bit / symbol clock, GSM
54
/1875
13.867 kHz (0.072 ms)
Slot clock (1/8 slot)
55
/2
6.933 kHz (0.144 ms)
Slot clock (1/4 slot)
56
/2
3.467 kHz (0.288 ms)
Slot clock (1/2 slot)
57
/2
1.733 kHz (0.577 ms)
Slot clock (full slot)
58
/8
216.667 Hz (4.615 ms)
Frame clock

Fig. 5

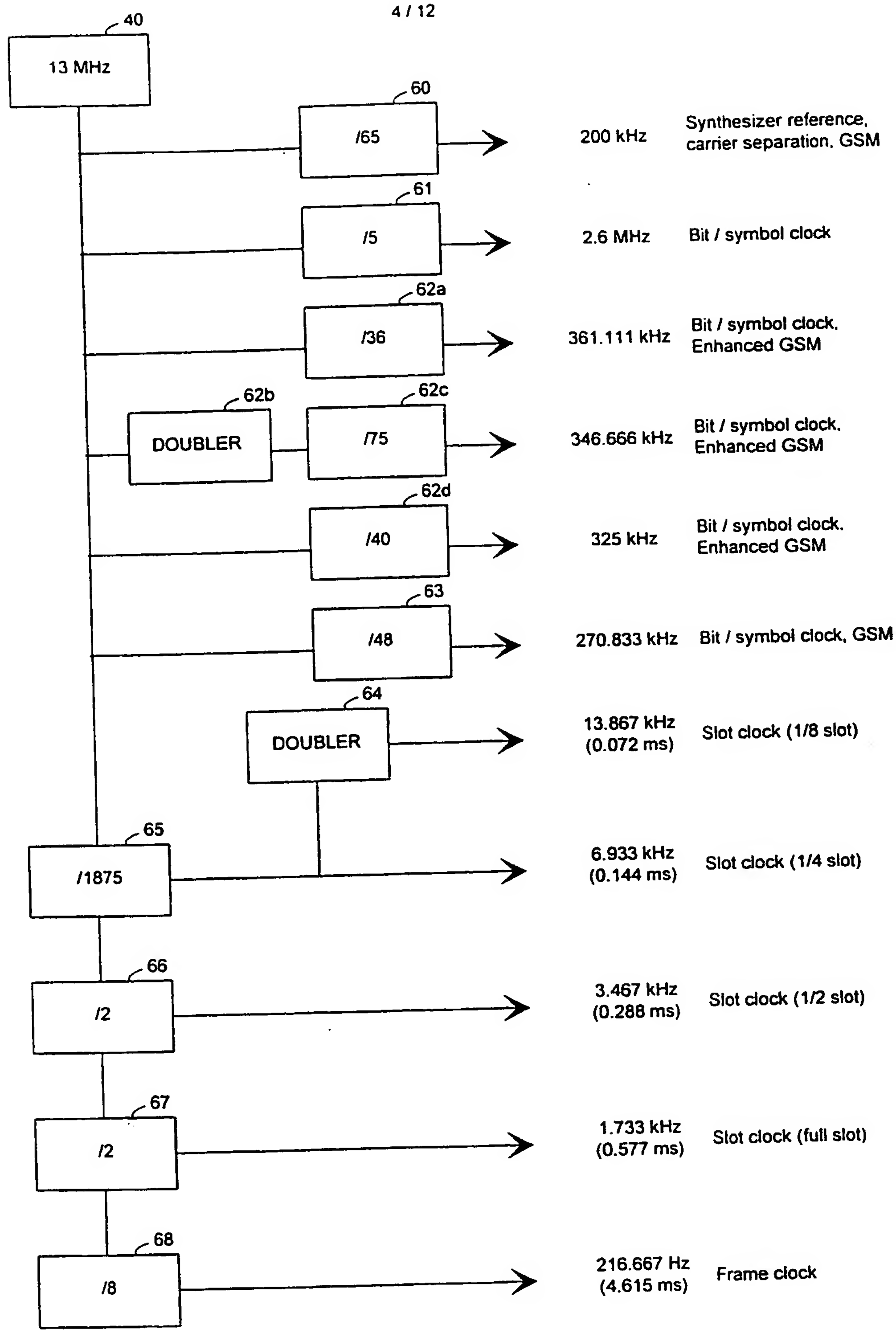

40
13 MHz
60
/65
200 kHz
Synthesizer reference, carrier separation, GSM
61
/5
2.6 MHz
Bit / symbol clock
62a
/36
361.111 kHz
Bit / symbol clock, Enhanced GSM
62b
DOUBLER
62c
/75
346.666 kHz
Bit / symbol clock, Enhanced GSM
62d
/40
325 kHz
Bit / symbol clock, Enhanced GSM
63
/48
270.833 kHz
Bit / symbol clock, GSM
64
DOUBLER
13.867 kHz (0.072 ms)
Slot clock (1/8 slot)
65
/1875
6.933 kHz (0.144 ms)
Slot clock (1/4 slot)
66
/2
3.467 kHz (0.288 ms)
Slot clock (1/2 slot)
67
/2
1.733 kHz (0.577 ms)
Slot clock (full slot)
68
/8
216.667 Hz (4.615 ms)
Frame clock

Fig. 6

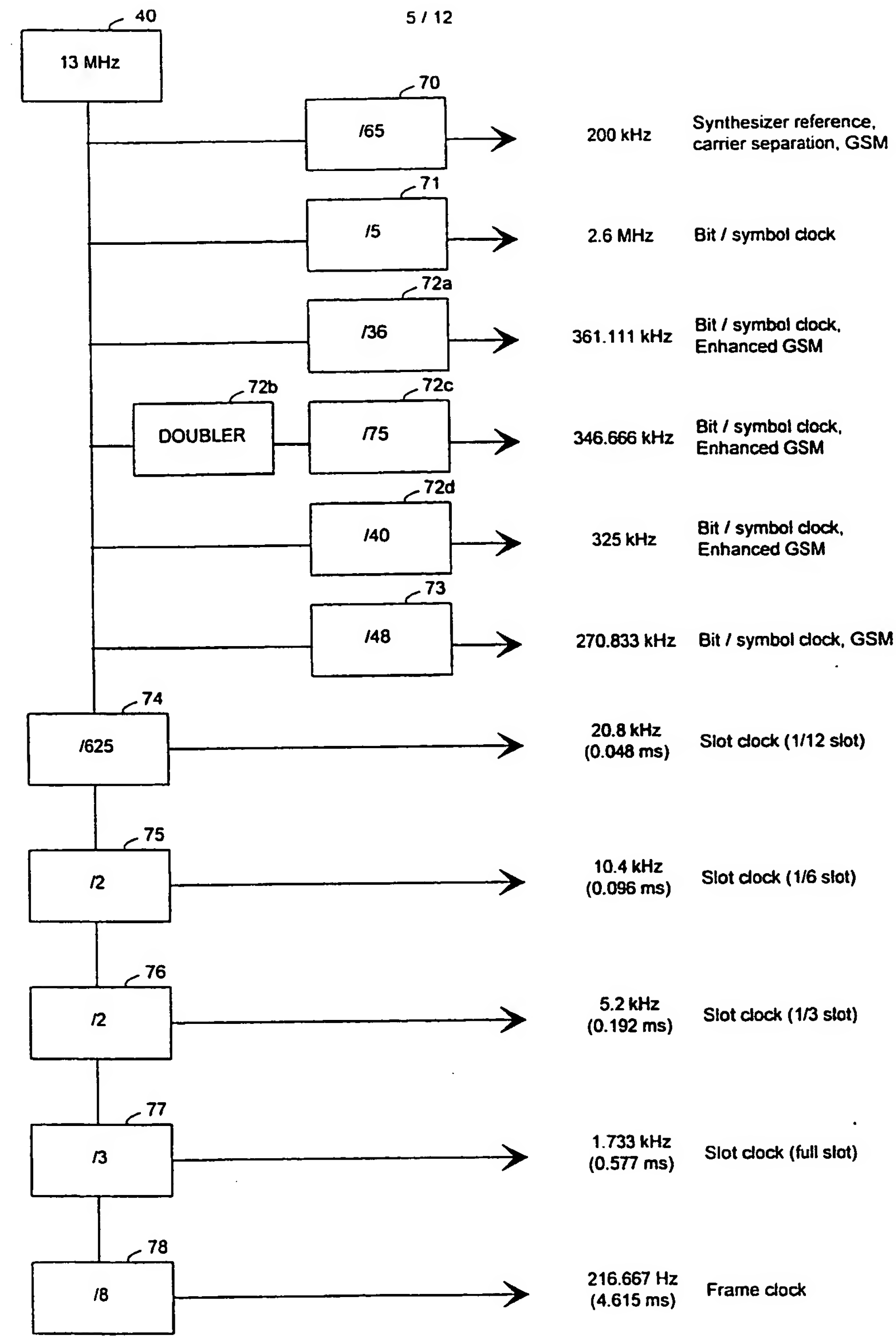

40
13 MHz
70
/65
200 kHz
Synthesizer reference, carrier separation, GSM
71
/5
2.6 MHz
Bit / symbol clock
72a
/36
361.111 kHz
Bit / symbol clock, Enhanced GSM
72b
DOUBLER
72c
/75
346.666 kHz
Bit / symbol clock, Enhanced GSM
72d
/40
325 kHz
Bit / symbol clock, Enhanced GSM
73
/48
270.833 kHz
Bit / symbol clock, GSM
74
/625
20.8 kHz (0.048 ms)
Slot clock (1/12 slot)
75
/2
10.4 kHz (0.096 ms)
Slot clock (1/6 slot)
76
/2
5.2 kHz (0.192 ms)
Slot clock (1/3 slot)
77
/3
1.733 kHz (0.577 ms)
Slot clock (full slot)
78
/8
216.667 Hz (4.615 ms)
Frame clock

Fig. 7

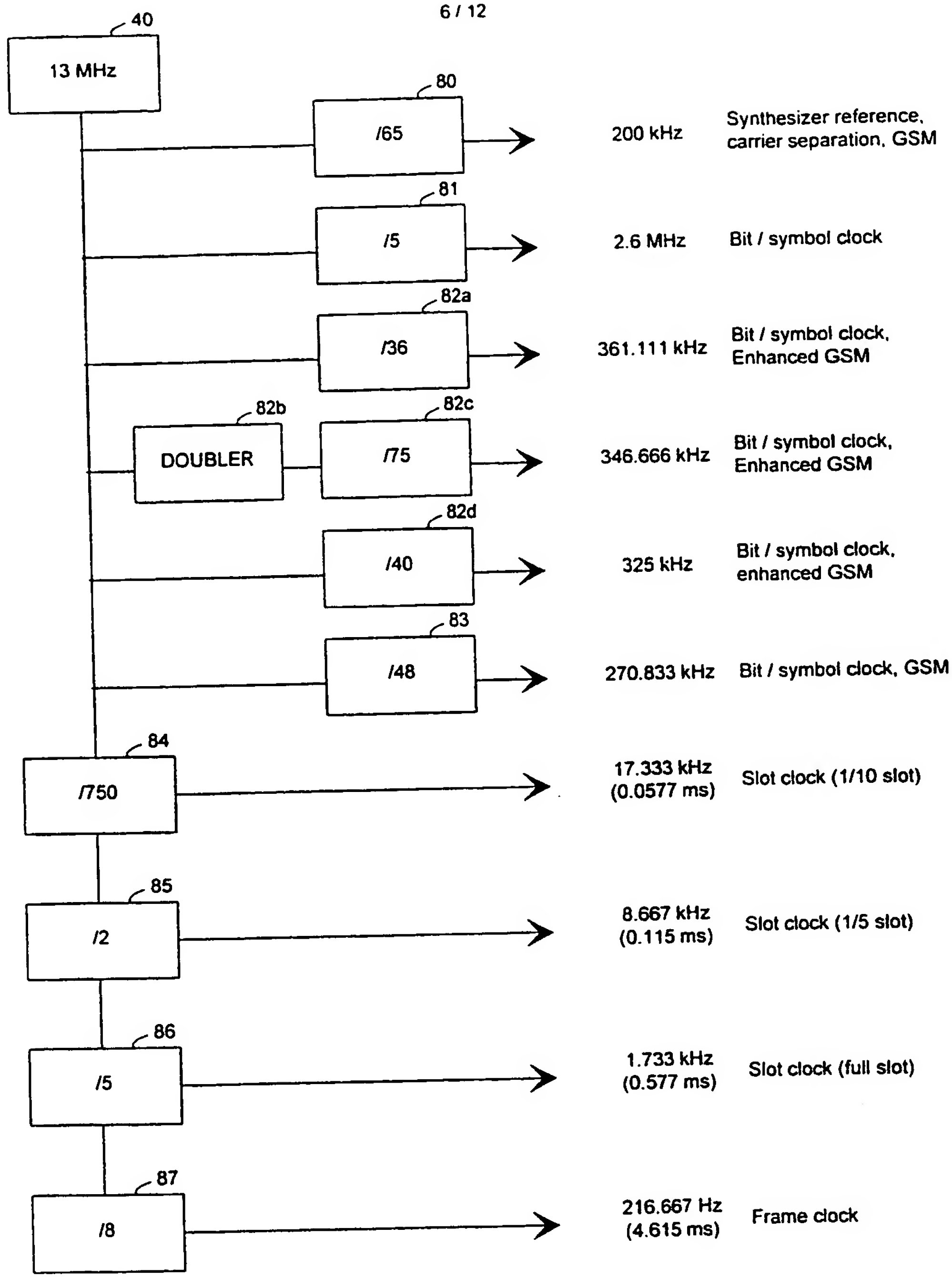

40
13 MHz
80
/65
200 kHz
Synthesizer reference, carrier separation, GSM
81
/5
2.6 MHz
Bit / symbol clock
82a
/36
361.111 kHz
Bit / symbol clock, Enhanced GSM
82b
DOUBLER
82c
/75
346.666 kHz
Bit / symbol clock, Enhanced GSM
82d
/40
325 kHz
Bit / symbol clock, enhanced GSM
83
/48
270.833 kHz
Bit / symbol clock, GSM
84
/750
17.333 kHz (0.0577 ms)
Slot clock (1/10 slot)
85
/2
8.667 kHz (0.115 ms)
Slot clock (1/5 slot)
86
/5
1.733 kHz (0.577 ms)
Slot clock (full slot)
87
/8
216.667 Hz (4.615 ms)
Frame clock

Fig. 8

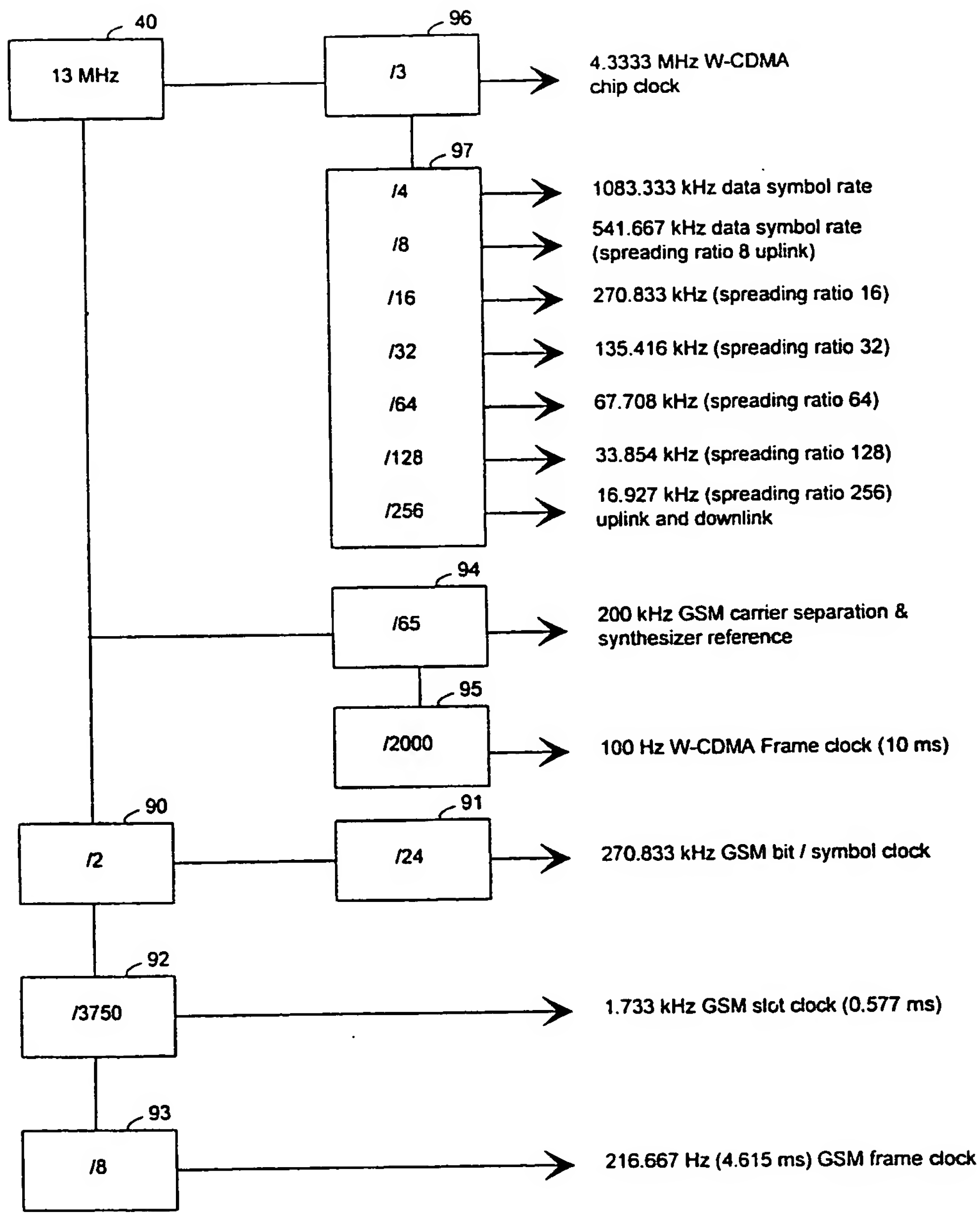

40
13 MHz
96
/3
4.3333 MHz W-CDMA chip clock
97
/4
1083.333 kHz data symbol rate
/8
541.667 kHz data symbol rate (spreading ratio 8 uplink)
/16
270.833 kHz (spreading ratio 16)
/32
135.416 kHz (spreading ratio 32)
/64
67.708 kHz (spreading ratio 64)
/128
33.854 kHz (spreading ratio 128)
/256
16.927 kHz (spreading ratio 256) uplink and downlink
94
/65
200 kHz GSM carrier separation & synthesizer reference
95
/2000
100 Hz W-CDMA Frame clock (10 ms)
90
/2
91
/24
270.833 kHz GSM bit / symbol clock
92
/3750
1.733 kHz GSM slot clock (0.577 ms)
93
/8
216.667 Hz (4.615 ms) GSM frame clock

Fig. 9

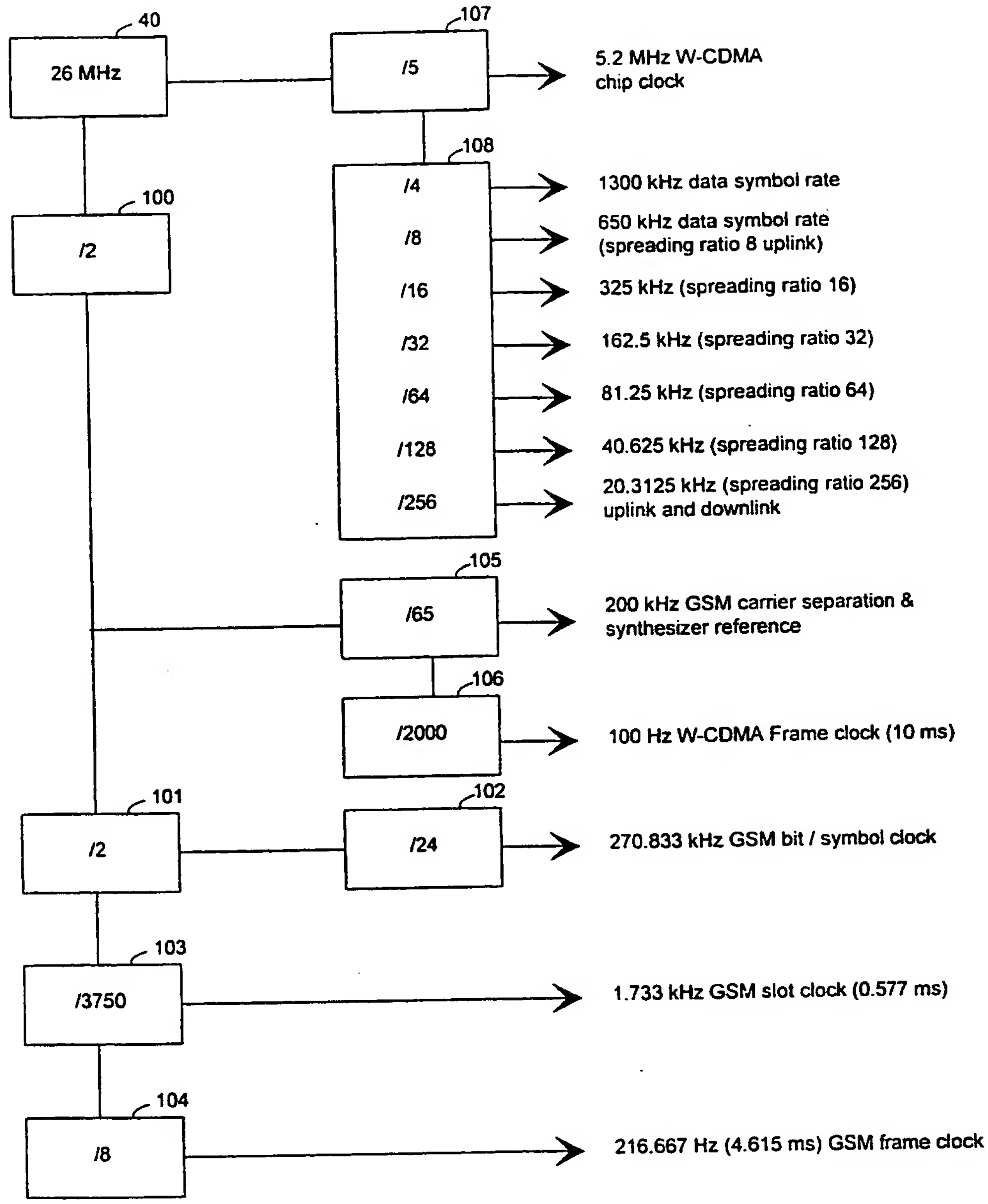

40
26 MHz
107
/5
5.2 MHz W-CDMA chip clock
108
/4
1300 kHz data symbol rate
100
/2
/8
650 kHz data symbol rate (spreading ratio 8 uplink)
/16
325 kHz (spreading ratio 16)
/32
162.5 kHz (spreading ratio 32)
/64
81.25 kHz (spreading ratio 64)
/128
40.625 kHz (spreading ratio 128)
/256
20.3125 kHz (spreading ratio 256) uplink and downlink
105
/65
200 kHz GSM carrier separation & synthesizer reference
106
/2000
100 Hz W-CDMA Frame clock (10 ms)
101
/2
102
/24
270.833 kHz GSM bit / symbol clock
103
/3750
1.733 kHz GSM slot clock (0.577 ms)
104
/8
216.667 Hz (4.615 ms) GSM frame clock

Fig. 10

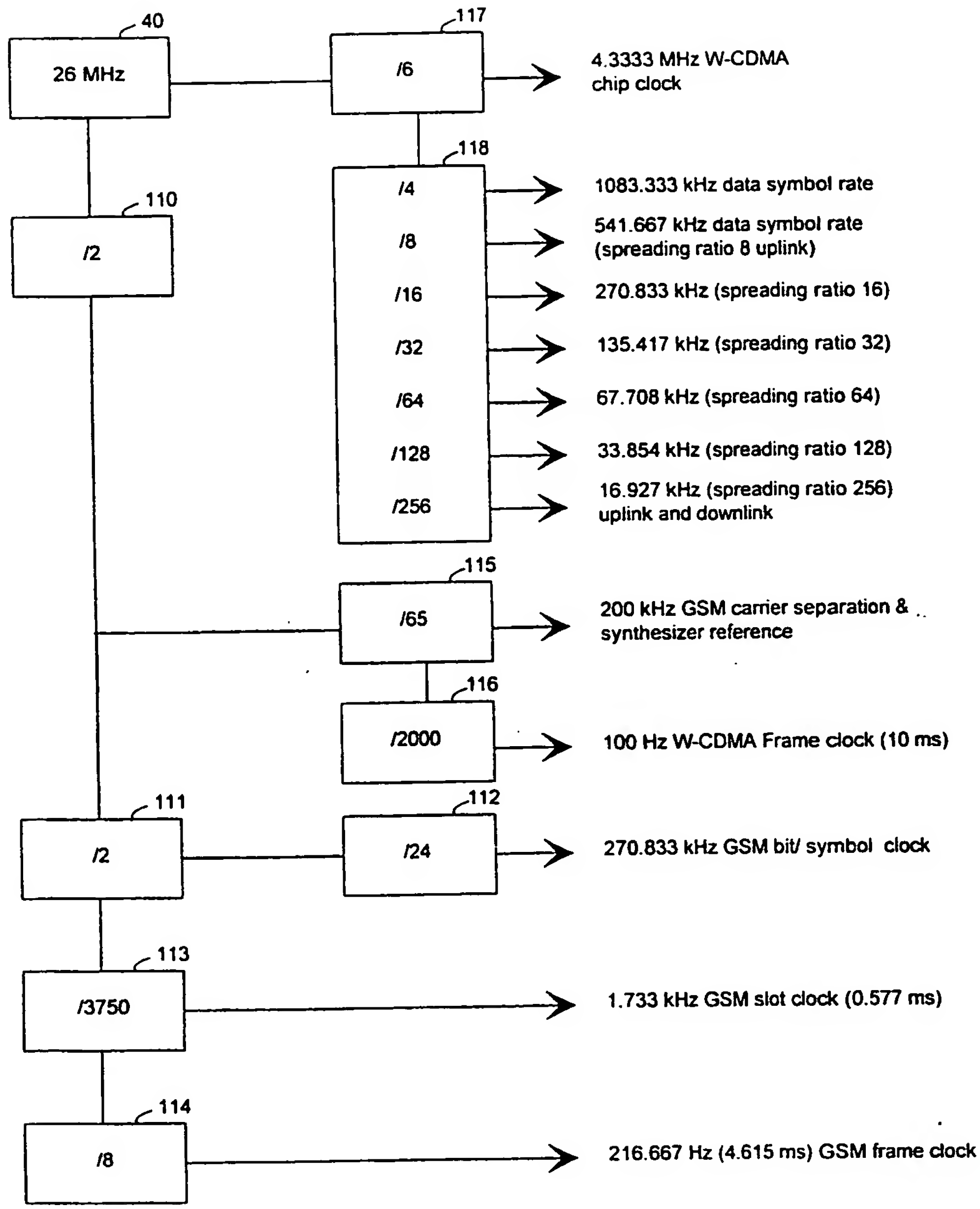
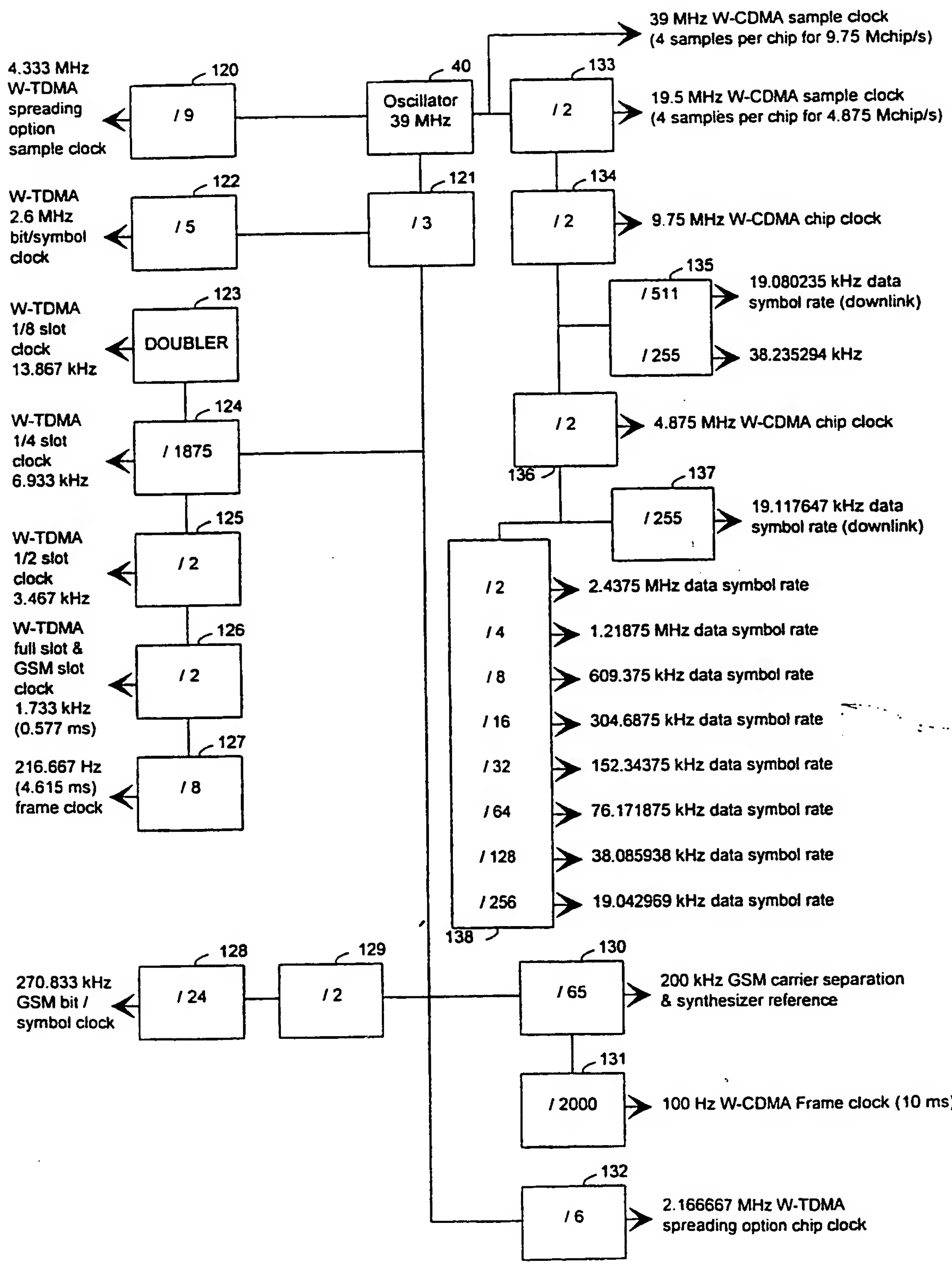

40
26 MHz
117
/6
4.3333 MHz W-CDMA chip clock
118
/4
/8
/16
/32
/64
/128
/256
1083.333 kHz data symbol rate
541.667 kHz data symbol rate (spreading ratio 8 uplink)
270.833 kHz (spreading ratio 16)
135.417 kHz (spreading ratio 32)
67.708 kHz (spreading ratio 64)
33.854 kHz (spreading ratio 128)
16.927 kHz (spreading ratio 256) uplink and downlink
110
/2
115
/65
200 kHz GSM carrier separation & synthesizer reference
116
/2000
100 Hz W-CDMA Frame clock (10 ms)
111
/2
112
/24
270.833 kHz GSM bit/ symbol clock
113
/3750
1.733 kHz GSM slot clock (0.577 ms)
114
/8
216.667 Hz (4.615 ms) GSM frame clock

Fig. 11



39 MHz W-CDMA sample clock (4 samples per chip for 9.75 Mchip/s)
4.333 MHz W-TDMA spreading option sample clock
120
/ 9
40
Oscillator 39 MHz
133
/ 2
19.5 MHz W-CDMA sample clock (4 samples per chip for 4.875 Mchip/s)
W-TDMA 2.6 MHz bit/symbol clock
122
/ 5
121
/ 3
134
/ 2
9.75 MHz W-CDMA chip clock
135
/ 511
19.080235 kHz data symbol rate (downlink)
/ 255
38.235294 kHz
W-TDMA 1/8 slot clock 13.867 kHz
123
DOUBLER
/ 2
4.875 MHz W-CDMA chip clock
W-TDMA 1/4 slot clock 6.933 kHz
124
/ 1875
136
137
/ 255
19.117647 kHz data symbol rate (downlink)
W-TDMA 1/2 slot clock 3.467 kHz
125
/ 2
W-TDMA full slot & GSM slot clock 1.733 kHz (0.577 ms)
126
/ 2
216.667 Hz (4.615 ms) frame clock
127
/ 8
/ 2
2.4375 MHz data symbol rate
/ 4
1.21875 MHz data symbol rate
/ 8
609.375 kHz data symbol rate
/ 16
304.6875 kHz data symbol rate
/ 32
152.34375 kHz data symbol rate
/ 64
76.171875 kHz data symbol rate
/ 128
38.085938 kHz data symbol rate
/ 256
19.042969 kHz data symbol rate
138
270.833 kHz GSM bit / symbol clock
128
/ 24
129
/ 2
130
/ 65
200 kHz GSM carrier separation & synthesizer reference
131
/ 2000
100 Hz W-CDMA Frame clock (10 ms)
132
/ 6
2.166667 MHz W-TDMA spreading option chip clock

Fig. 12

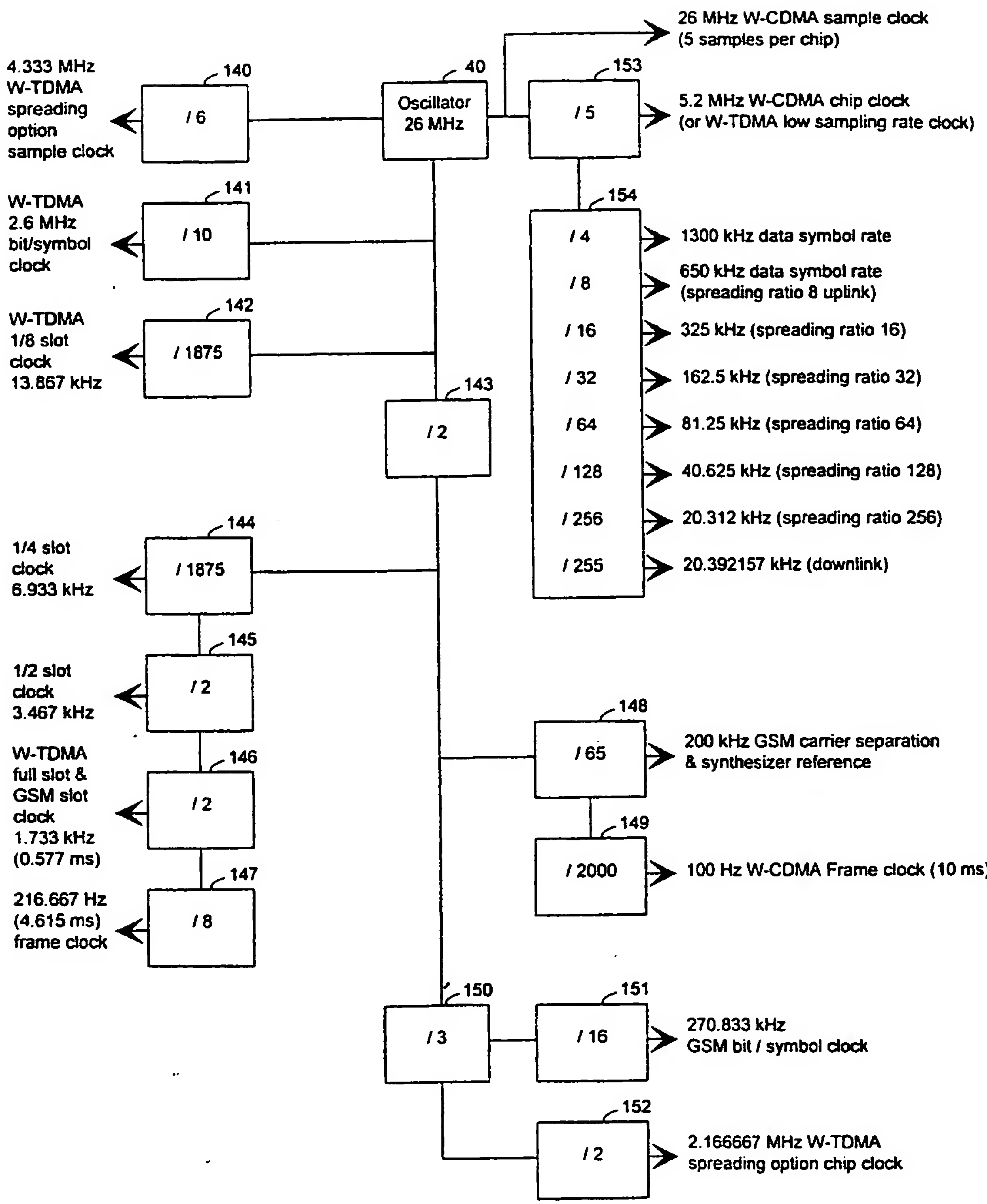

26 MHz W-CDMA sample clock
(5 samples per chip)
4.333 MHz W-TDMA spreading option sample clock
140
/ 6
40
Oscillator 26 MHz
153
/ 5
5.2 MHz W-CDMA chip clock
(or W-TDMA low sampling rate clock)
W-TDMA 2.6 MHz bit/symbol clock
141
/ 10
154
/ 4
1300 kHz data symbol rate
/ 8
650 kHz data symbol rate
(spreading ratio 8 uplink)
W-TDMA 1/8 slot clock 13.867 kHz
142
/ 1875
/ 16
325 kHz (spreading ratio 16)
/ 32
162.5 kHz (spreading ratio 32)
143
/ 2
/ 64
81.25 kHz (spreading ratio 64)
/ 128
40.625 kHz (spreading ratio 128)
/ 256
20.312 kHz (spreading ratio 256)
/ 255
20.392157 kHz (downlink)
1/4 slot clock 6.933 kHz
144
/ 1875
1/2 slot clock 3.467 kHz
145
/ 2
148
/ 65
200 kHz GSM carrier separation
& synthesizer reference
W-TDMA full slot & GSM slot clock 1.733 kHz (0.577 ms)
146
/ 2
149
/ 2000
100 Hz W-CDMA Frame clock (10 ms)
216.667 Hz (4.615 ms) frame clock
147
/ 8
150
/ 3
151
/ 16
270.833 kHz
GSM bit / symbol clock
152
/ 2
2.166667 MHz W-TDMA
spreading option chip clock

Fig. 13

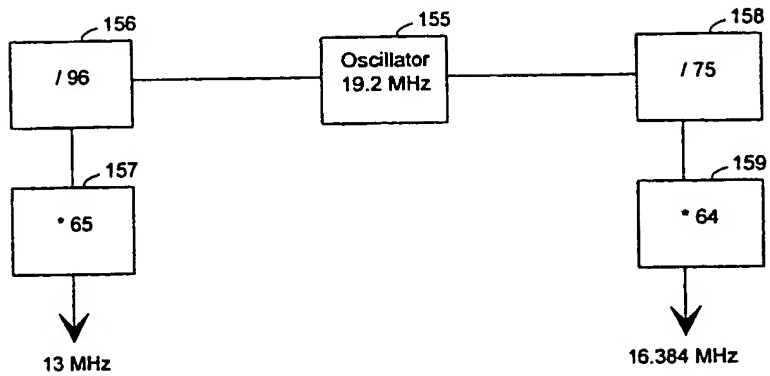

156
/ 96
155
Oscillator
19.2 MHz
158
/ 75
157
* 65
159
* 64
13 MHz
16.384 MHz

Fig. 14

INTERNATIONAL SEARCH REPORT

International Application No
PCT/FI 97/00689

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H03B21/02 H04B1/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H03B H04B H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 08883 A (ERICSSON GE MOBILE INC) 21 March 1996 cited in the application see page 3, line 3 - page 11, line 4; figures 1,2 ---	1,16
A	EP 0 186 068 A (TELEFONGYAR) 2 July 1986 see abstract; figures 1-6 ---	1,16
A	EP 0 581 573 A (NOKIA MOBILE PHONES LTD) 2 February 1994 see page 2, line 1 - line 56; figure 1 ---	1,16
A	EP 0 729 238 A (SONY CORP) 28 August 1996 see column 1, line 1 - column 8, line 44; figure 2 --- -/--	1,16

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

2

Date of the actual completion of the international search	Date of mailing of the international search report
16 February 1998	20/02/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dhondt, I

INTERNATIONAL SEARCH REPORT

Interna ıl Application No
PCT/FI 97/00689

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 678 974 A (NOKIA MOBILE PHONES LTD) 25 October 1995 -----	

2

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/FI 97/00689

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9608883 A	21-03-96	US 5535432 A	09-07-96
		AU 3729795 A	29-03-96
		EP 0781475 A	02-07-97
		FI 971055 A	14-05-97
		US 5610559 A	11-03-97
EP 0186068 A	02-07-86	WO 8603909 A	03-07-86
EP 0581573 A	02-02-94	JP 6209235 A	26-07-94
		US 5471652 A	28-11-95
EP 0729238 A	28-08-96	JP 8223071 A	30-08-96
		CN 1134067 A	23-10-96
EP 0678974 A	25-10-95	FI 941862 A	22-10-95

Docket # L&L-I0177

Applic. #__________

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